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A Technology Transfer Model for Effective HIV/AIDS Interventions: Science and Practice

Joan Marie Kraft, Ph.D., Jane S. Mezoff, Dr.PH, CHES, Ellen D. Sogolow, Ph.D., Mary Spink Neumann, Ph.D., and Pat A. Thomas, M.A.

The widespread use of effective, science-based interventions to motivate and sustain behavior change provides an important approach to reducing the spread of HIV. The process of disseminating information about effective interventions and building capacity for implementing them in field settings must be improved, however. Starting with a review of diffusion of innovations and technology transfer literature, we offer a technology transfer model for HIV interventions. We identify participants and activities directed toward the use of effective interventions by prevention services providers (e.g., health departments and community-based organizations) in each phase of technology transfer: preimplementation, implementation, and maintenance and evolution. Preimplementation activities focus on selecting an intervention and preparing for implementation. Implementation activities include initial implementation and process evaluation. Maintenance and evolution are ongoing with continued support for and evaluation of the intervention. This article takes the perspective of providers. Other perspectives are presented elsewhere in this issue.

With much work to be done to achieve a vaccine or a cure, the most effective mechanism for halting the spread of HIV may be the widespread use of interventions to alter behaviors that place people at risk for infection. Since public understanding of HIV has grown and research has identified effective interventions, prevention efforts can move from educational messages to behavioral and social science-based interventions that motivate and sustain behavior change (Cain, 1997). Whether they focus on individuals, groups, or communities, such interventions attempt to change individual attitudes, beliefs, skills, and risk behaviors associated with HIV transmission as well as community and social conditions that encourage risk behavior (National Institutes of Health, 1997). "Prevention services providers," or agencies such as state or local health departments and community-based organizations (CBOs) that deliver inter-

Joan Marie Kraft, Jane S. Mezoff, Ellen D. Sogolow, and Mary Spink Neumann, are with the Division of HIV/AIDS Prevention Intervention Research and Support, National Center for HIV, STD, and TB Prevention, Centers for Disease Control and Prevention (CDC), Atlanta, Georgia. Dr. Kraft is now in the Division of Reproductive Health, and Dr. Mezoff is in the Division of Reproductive Health, National Center for Chronic Disease Prevention and Health Promotion, CDC. Pat A. Thomas is with the CDC Computer Information Systems Support Services Project, TRW, Inc., Atlanta, GA.

Address correspondence to Joan Marie Kraft, Division of Reproductive Health, Centers for Disease Control and Prevention, MS34, 4770 Buford Hwy, NE, Atlanta, GA 30341; e-mail: jik4@cdc.gov.

ventions, have been slow to implement science-based interventions. For instance, although a number of group-based interventions have been shown to be effective, fewer than half of the CBOs in a national survey offered workshops to encourage risk self-appraisal and teach risk-reduction skills (Somlai et al., 1999). This situation is understandable, given the limited resources for gaining access to information about and implementing the interventions.

We propose a model for technology transfer to facilitate the adoption and use of effective science-based interventions. We use the term *technology transfer* to encompass the translation, dissemination, and acquisition of information about interventions, the process of deciding whether to use an intervention, the tailoring of the intervention, and the provision of training and technical assistance (TA)—programmatic, scientific, or technical support to providers for planning and implementation. We take the perspective of prevention services providers here, as other perspectives are described in elsewhere in this issue (Neumann & Sogolow, 2000; Sogolow et al., 2000).

BACKGROUND

In 1994 the Centers for Disease Control and Prevention (CDC) implemented HIV Prevention Community Planning and charged community planning groups (CPGs) with reviewing epidemiologic and behavioral data and considering behavioral and social science-based approaches to set state and local intervention priorities (Centers for Disease Control and Prevention, 1999).[1] Despite support for this approach from health department staff and representatives of affected communities (Valdiserri, 1996), and CBO staff and administrators' beliefs that theory-based interventions are effective (DiFranceisco et al., 1999), prevention services providers report barriers to implementing these kinds of interventions (DeGroff, 1996).

Prevention services providers have had difficulty gaining access to information and transferring interventions from experimental to field or real-life settings, creating a gap between their goals and practice. This has occurred for several reasons. Traditional dissemination sources (e.g., journals and professional meetings) are not accessible to all providers (DeGroff, 1996) and may not provide practical information about interventions. CBO staff and CPG members reported other barriers, including cost and staff constraints; lack of interest by or support from target populations, communities, and administrators; poor communication with researchers; and concerns about whether and how to transfer interventions tested in one location for one population to other locations and populations (Collins & Franks, 1996; DeGroff, 1996; DiFranceisco et al., 1999).

These barriers suggest the need for an approach to technology transfer that rests on clear communication among prevention services providers, researchers, and other participants in technology transfer. Although the nature and amount of communication will depend on providers' capacity for implementing interventions, providers need researchers and others to clearly communicate, through accessible channels, prevention research findings and methods for delivering interventions so that providers can plan for and implement interventions that have been shown to be effective (Cameron, Brown, & Best, 1996; David, 1991). For technology transfer to

[1] CPGs are composed of representative of health departments and CBOs as well as persons infected with and affected by HIV/AIDS.

be successful, however, prevention services providers must take an active role in all phases. Providers have knowledge of and experience with their own organizations, populations they serve, and local conditions that should influence the development and testing of interventions by researchers. Also, providers can supply researchers with information on issues of adoption, tailoring, and successful implementation in field settings.

A MODEL OF TECHNOLOGY TRANSFER FOR HIV INTERVENTIONS

To identify potential elements for the model, we reviewed the literature, developed a draft model, and sought feedback from prevention services providers and researchers. We searched automated databases (Medline, AIDSLINE, and Current Contents/Social and Behavioral Sciences) for the past 10 years using the key words *technology transfer, diffusion of innovations, technical assistance, training,* and *dissemination.* The searches yielded references to articles, chapters, and presentations on controlled trials, retrospective studies, and descriptions of projects in HIV, as well as other areas of health promotion and business. Based on our analysis of the reports, we identified basic elements of the transfer process—participants in technology transfer and activities directed toward the use of science-based interventions—and developed a draft model and submitted it to prevention researchers and providers for review and comment (see Acknowledgments for a list of researchers and providers who met to discuss the draft model). Their feedback suggested revisions to the model.

Existing models of technology transfer for health promotion interventions suggest that these activities take place in phases, beginning with the identification of prevention needs and moving through initial implementation to changes in the intervention and the provider organization that support continued use of the intervention (e.g., King, Hawe, & Wise, 1998; Kolbe & Iverson, 1981). Based on these models, our model for HIV prevention includes participants who undertake activities in the three major phases: preimplementation, implementation, and maintenance and evolution (see Table 1). The preimplementation phase focuses on identifying interventions and preparing for initial implementation. Implementation includes using the intervention for the first time and conducting process evaluation. Activities in the final phase draw attention to the need for continued support for and evaluation of the intervention to assess whether it should be altered or replaced.

Prevention services providers and researchers are key participants in technology transfer. *Linking agents* are mediators who facilitate technology transfer by helping to translate and disseminate information, working with providers to tailor interventions and identify TA needs, and attempting to bridge the communication gap between researchers and providers (Goodman, Tenney, Smith, & Steckler, 1992). Prevention services providers might engage community groups, organizations, and members of the target population by asking for their input throughout the process.

PREIMPLEMENTATION

During the preimplementation phase, prevention services providers, advisory boards, members of target populations, CPGs, prevention researchers, and linking agents identify local prevention needs and interventions that address these needs, de-

Table 1. Overview of technology transfer model

Phase	Participants	Activities
Preimplementation	Prevention services providers Community planning groups Advisory boards Target population members External organizations Prevention researchers Linking agents Trainers	1. Identify need for new intervention, considering: • epidemiologic and behavioral data • community assessments • public opinion and external organizations 2. Acquire information through: • formal channels, including intervention packages • informal channels 3. Assess fit by considering: • effectiveness and feasibility • organizational characteristics • access to other services in community 4. Prepare the organization and staff • mobilize support • tailor the intervention • provide training
Implementation	Prevention services providers Target population members TA providers Prevention researchers Linking agents	1. Secure technical assistance for: • implementation • organizational changes 2. Conduct process evaluation • monitor delivery of intervention • assess quality of delivery
Maintenance and Evolution	Prevention services providers TA providers	1. Support staff for continued implementation • provide new staff and booster training • provide ongoing TA 2. Support organization change and institutionalization • secure funding • ensure that competing needs do not undercut intervention • incorporate intervention into job duties 3. Conduct process, outcome, and cost evaluations

Note. TA = technical assistance.

cide whether an intervention "fits" the organization, and decide whether to "adopt," or use the intervention. As they gather information and decide whether to use an intervention, providers might consider the local epidemic, public opinion and external groups, intervention and organizational characteristics, and their relationships with other organizations in the area. If the organization decides to adopt the intervention, it must prepare for implementation by mobilizing support for the intervention, tailoring the intervention, and providing training.

Identify Need for a New Intervention

Technology transfer begins when CPGs or prevention services providers identify a need for a new intervention, either one they have not used before or one recently reported in the literature as effective. Several factors may encourage them to consider new interventions. First, CPGs systematically identify prevention needs when they review epidemiologic and behavioral data to develop yearly plans that identify priority populations and prevention strategies. Second, the need for a new intervention might be recognized as a result of a community risk and resources assessment. For instance, Communities That Care trains community coalitions to conduct a community risk and resources assessment and to use data from the assessment to select an effective intervention aimed at reducing substance abuse (Harachi, Ayers, Hawkins, Catalano, & Cushing, 1996). Third, providers may be influenced by environmental stimuli, such as public opinion. For instance, Rogers (1995) argued that DARE (drug abuse prevention) diffused rapidly because of public concern stimulated by media reports of a drug problem. In addition, external groups or organizations, such as regulatory boards, citizen groups, advocacy groups, and legislative bodies, can act as catalysts or barriers to the use of an intervention, suggesting that any of the groups might veto changes in interventions by mental health organizations (Backer, Liberman, & Kuehnel, 1986).

As described in other articles in this issue, other participants in technology transfer (e.g., researchers, federal agencies) may identify effective interventions for transfer and develop and disseminate intervention packages that will help providers decide whether to adopt an intervention (Kegeles et al., 2000; Neumann & Sogolow, 2000).

Acquire Information About Interventions

In addition to learning about interventions from intervention packages, prevention services providers may learn about interventions through formal and informal channels of communication. Formal channels used and rated as important by respondents to one national survey of CBOs include the AIDS Clearinghouse (now known as the National Prevention Information Network) and workshops or training sessions at local, regional, or national conferences (Goldstein, Wrubel, Faigeles, & DeCarlo, 1998). The Internet may become an increasingly important formal channel for acquiring information. Formal channels may be important for learning about a variety of potential interventions from which to choose.

Other sources of information are informal contacts with colleagues at other CBOs, staff who move from one agency to another, and behavioral or social scientists at local colleges or agencies (Goldstein et al., 1998; Kalichman, Belcher, Cherry, & Williams, 1997). Informal contacts may be especially important in technology transfer, as they may have already sorted through the information and can relay their opinions and conclusions (Malecki & Tootle, 1996) which might help providers narrow down the number of interventions to consider.

Assess Fit

Literature on the adoption of other health interventions suggests that providers, possibly in conjunction with linking agents, members of the target population, and advisory boards, should assess whether an intervention fits their prevention needs. An important foundation for this activity is an orientation to, or overview of, the intervention, its core elements, and resource requirements. Such an orientation may be

provided in intervention materials or training for administrators and staff. In particular, this activity focuses attention on effectiveness and feasibility of using the intervention and on characteristics of the organization.

Although the answers may not always be clear, providers should consider whether the intervention is likely to be more effective than current practices and whether the effects can be readily measured. Deciding whether the intervention is conceptually plausible might provide insight into whether it will be effective in their setting. In considering feasibility, providers should think about complexity, flexibility, whether the intervention can be phased out in favor of earlier practices, whether the intervention can be implemented on a limited basis, and risk (e.g., Kolbe & Iverson, 1981; Mesters & Meertens, 1999; Orlandi, 1986; van Assema, Brug, Glanz, Dolders, & Mudde, 1998). Prevention services providers should also assess whether the intervention will be acceptable to the target population and whether they have access to resources for the intervention. Resources to consider include short- and long-term funding needs; access to the target population; staff, administrative, and volunteer time and skill for training, implementation, and supervision; and facilities for staff and volunteer training and implementing the intervention.

Organizational characteristics influencing fit center on whether the intervention is compatible with the agency's organizational mission, values, and practices. Another organizational consideration focuses on requirements of the intervention that may necessitate changes in the organization, including changes in communication, authority, and reward systems (Zaltman & Lin, 1971). For instance, community-level interventions, such as the Mpowerment Project, call for community participation in both planning and implementation (Kegeles, Hays, & Coates, 1996). Some organizations may hesitate to share control of services. Other considerations include whether the intervention relies on or induces changes in relationships with other HIV prevention services providers or with health care and social service providers. For instance, some interventions may require referrals to other social services in the community.

Activities conducted and information exchanged to this point will help administrators and staff decide whether to adopt an intervention. If they do not adopt it, they may continue current practices or go back to the beginning of this technology transfer phase to evaluate another intervention. If they do adopt the intervention, they should prepare for implementation by mobilizing support, tailoring the intervention, and providing training.

Prepare the Organization and Staff

Mobilizing support for the intervention is critical; without it, the intervention may not be implemented, or if implemented, may not become a routine part of the organization's activities (Leonard-Barton, 1988). Studies of technology transfer in health promotion suggest that one person acting as a "champion" can mobilize support for implementation (e.g., Gendreau, 1996; Leonard-Barton, 1988). The champion anticipates and responds to staff members' reservations, such as concerns about changes in job duties (Barker, 1990), changes in professional identity (Jaffe, 1998), changes in the organizational structure, and the efficacy of the new intervention, especially if it appears to conflict with current theoretical orientations (Keller & Galanter, 1999). The champion overcomes reservations by facilitating staff participation (Leonard-Barton, 1988), keeping staff members focused on implementation (Becker, Torrey, Toscano, Wyzik, & Fox, 1998), securing resources (Cohen, 1997), providing evidence that the intervention is effective (Martinez-Brawley, 1995), finding ways to reward staff mem-

bers (Bhattacherjee, 1998), and negotiating trade-offs and compromises that might be necessary (Steckler & Goodman, 1989).

Because many of the program champion's tasks require access to organizational and community resources or a knowledge of key parties and their views, a mid- to upper-level administrator might be an effective champion. In addition, a successful champion will likely need negotiating skills to balance the concerns of different parties and skills for promoting the program (Steckler & Goodman, 1989). Some champions may require training or other assistance to achieve their goals.

If staff members or external participants in technology transfer (e.g., community groups) suggest a new intervention, then administrative support will have to be mobilized by addressing their reservations about the intervention, which might include questions about the need and funding for the intervention, its acceptability, and its contribution to the organization's prevention program. Linking agents and researchers may assist in mobilizing support among administrators (Adams et al., 2000).

Mobilizing the support of external collaborators is also crucial because prevention services providers work with other service organizations, funding and government agencies, advocacy groups, and target populations. Cain (1997) suggested that CBOs can mobilize support (e.g., information, money, personnel, facilities, and clients) from other CBOs in their networks. Network members might also collaborate to mobilize community resources, develop political coalitions, achieve legitimacy, and develop HIV prevention policies.

Technology transfer models highlight the importance of tailoring, or customizing delivery of interventions to agency circumstances and ensuring that messages are appropriate for target populations without altering, deleting, or adding to the intervention's core elements (e.g., Tenkasi & Mohrman, 1995).[2] Such assumptions recognize the need for cultural relevance and flexibility in field settings. For instance, during the research trial, a community-level intervention used paid outreach workers to assess women's stage of change for condom use (Lauby, Smith, Stark, Person, & Adams, 2000). However, in field settings, paying outreach workers may not be feasible, especially for smaller CBOs. Thus, prevention services providers must decide whether it is possible to train and use volunteers and whether the change will compromise effectiveness. Because it is unlikely that providers have resources for feasibility studies to assess whether changes will compromise effectiveness, they will need some guidelines for tailoring.

Bauman and her colleagues (1991) suggested that researchers can help providers balance fidelity to the intervention as tested with the need to tailor it by developing guidelines that describe the theory on which the intervention is based, its causal mechanism, and the way in which implementation parameters, or features of a setting and its context, might affect implementation. They argued that fidelity to causal mechanisms is essential and that "reinvention" or change can occur because of differences in implementation parameters, such as staff characteristics (e.g., number and skills), organizational characteristics (e.g., authority structure), social and political contexts (e.g., laws), and target populations. For example, providers may have to decide whether paid volunteers can replace paid outreach workers. As illustrated by the Prevention Marketing Initiative (a CDC-funded demonstration project), formative data and guidelines can help prevention services providers tailor interventions (Kennedy, Seals, & Strand, 1998).

[2] In the literature, terms such as adaptation, modification, reinvention, and change are used interchangeably and in ways similar to our definition of tailoring, with the exception that the extent of permissible change is not always discussed.

Providing adequate training for staff is important. Training for HIV/AIDS interventions has taken many forms (e.g., interactive and experiential, didactic sessions, Web-based, videos, self-guided) and has been tailored for different target populations and for staff and volunteers with low levels of literacy (Gutierrez et al., 1998; Heft, 1998; Miller, Klotz, & Eckholdt, 1998; Stark, Dietz, Emerson, Shirah, & MacDonald, 1996). The content of training and the need for booster training will be determined by the intervention and by staff and volunteer skills but should include technical skills needed to deliver the intervention as designed (Adams et al., 2000). For instance, training for a group-based intervention might include instruction in and opportunities to practice group facilitation skills.

IMPLEMENTATION

To facilitate implementation and ensure that the intervention meets the needs of the target population, prevention services providers might work with TA providers to effect mutual adaptation in their organizations and in the intervention that allows for successful implementation (Kolbe & Iverson, 1981). In addition, prevention services providers should conduct process evaluation to ensure that the intervention was implemented as planned and that services reach the target population.

Secure Technical Assistance

Staff and administrators implement the intervention and make organizational changes (e.g., change staff reward structures, invite community members to participate in decision making). Because experience using science-based interventions and the ability to plan and implement organizational changes are likely to vary based on the organization's size and the expertise of its staff, TA may be needed. In-house evaluators (more likely for large CBOs), behavioral and social scientists at local colleges, or regional HIV prevention centers might provide TA (Kalichman et al., 1997). In addition, CDC's network of behavioral and social science volunteers can be called upon for TA.[3]

CDC surveys of CBOs that receive TA suggest that needs for assistance implementing interventions are varied and include continued tailoring, cultural sensitivity, and evaluation (Gentry et al., 1998; Gilliam, Taveras, Thompson, & Gentry, 1998). Experience with replication projects suggests that some providers need TA to overcome implementation barriers such as difficulty in recruiting clients (O'Donnell et al., 2000). In addition, the type of TA needed and the role of TA providers and prevention services providers varies throughout technology transfer (O'Donnell et al., 2000).

TA may be needed to implement organizational changes that support the intervention and to build capacity to plan for and use other science-based interventions. Depending on existing capacity, TA may be needed to enhance the organizational infrastructure for providing interventions (e.g., board development, fiscal management, management information systems, human resource management, strategic planning), mobilizing the community (e.g., leadership development, coalition building, community resource and needs assessments), and enhancing prevention services (e.g., service integration, cultural competency, program evaluation) (Centers for Disease Control and Prevention, 1997).

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[3] CBOs and health departments can gain access to CDC's network of Behavioral and Social Science Volunteers by contacting their CDC project officers.

Conduct Process Evaluation

Monitoring implementation through the collection and review of process data can focus energies and provide decision makers with information about whether the intervention was implemented as planned and whether quality services were delivered. In addition, process data can identify TA needs (Paine-Andrews et al., 1996) and additional modifications to the intervention. Researchers and TA providers should work with prevention services providers to develop instruments for process evaluation that include such measures as the number of times the intervention was delivered, the number of clients served, and which components of the intervention were delivered. Mechanisms for supervising staff and volunteers to assess the quality of services provided should be part of the process evaluation.

Administrators and staff should consider data from process evaluations as well as their impressions of the usefulness of the intervention when deciding whether to continue using the intervention. Those who continue using the intervention move on to the maintenance and evolution phase, whereas others may return to previous practices or consider other interventions.

MAINTENANCE AND EVOLUTION

Because successful implementation does not always result in continued use, prevention services providers should continue to attend to intervention activities and organizational changes (Steckler & Goodman, 1989). Institutionalization, or embedding the intervention into the organizational mission, hierarchy, standard operations, and budget (O'Loughlin, Renaud, Richard, Gomez, & Paradis, 1998), is a potential goal of this phase. Institutionalization is more likely to occur when the intervention has a champion, is consistent with organizational routines and objectives, provides benefits to the organization, can be maintained within an organization's budget, can be tailored, and involved community leaders and staff in decision-making and implementation (Elder et al., 1998; O'Loughlin, Renaud, Richard, Gomez, & Paradis, 1998; Steckler & Goodman, 1989). These considerations suggest that prevention services providers should continue to focus on staff support, organizational and intervention changes, and evaluation to determine whether to continue using the intervention and whether to make additional changes in the intervention or the organization to support the use of the intervention.

During this technology transfer phase, prevention services providers and TA providers continue to work on the mutual adaptation of the intervention and the organization and to evaluate the intervention. Along with evaluation findings, changes in target populations and community conditions influence whether the prevention services providers decide to continue using the intervention.

Support Staff for Continued Implementation

Despite the provision of booster training and training to new staff members, continued implementation may still yield problems. For instance, Hatwiinda and colleagues (1994) reported that 90% of staff who attended an AIDS management training seminar in Zambia felt they needed continued assistance to resolve problems and implement interventions. TA may range from one or two brief consultations to more intensive assistance in learning to use the intervention and adapt it to evolving needs, such as shifts in population risk.

Support Organizational Change and Institutionalization

Support of administrators remains important. Continued funding, efforts to make sure that the intervention is not undercut by other activities, and the integration of implementation activities into routine job duties can lead to institutionalization. For instance, the continued use of school-based health promotion interventions relied on administrators ensuring that teachers, administrators and staff participated in additional planning, training, and materials development and that administrators facilitated communication about the intervention among relevant participants (Havlicek, 1980). These factors likely apply to HIV prevention services providers. Administrators may need TA to accomplish some of these goals. For instance, TA providers may help administrators write grants to secure funding for the intervention.

Conduct Evaluations

In this era of limited funding for HIV prevention, evaluation should continue. Changes in staff, job duties, organizational priorities, target populations, and the nature of the epidemic may influence the extent to which an intervention continues to be implemented and to affect behavior. In addition to collecting and reviewing process data, prevention services providers should collect and review outcome and cost data. Although many CBOs cannot conduct full outcome and cost evaluations, some data on behavior change and costs are important for decision making.

Outcome and cost data, even of a modest sort, along with process data should help administrators and staff decide whether tailoring is needed, whether other organizational changes are needed, and ultimately whether to continue the intervention. Researchers, linking agents, or TA providers might assist by establishing criteria against which to judge whether the intervention may have changed behavior (Cameron et al., 1996).

During this technology transfer phase, decision making about the intervention is ongoing. Changes in the epidemic, changes in the target population, and analyses of process, outcome, and cost data influence decisions to continue using a particular intervention or to consider adopting another intervention.

SUMMARY

With the understanding that HIV interventions to motivate and sustain behavior change are neither naturally diffused nor automatically used, the proposed technology transfer model recognizes the importance of planning for and carrying out activities to encourage the use of effective interventions. This model draws attention to the need for clear communication between researchers and providers, intervention characteristics that make them suitable for different organizations and target populations, organizational characteristics that facilitate or impede use, and mutual adaptation of the intervention and the organization. The model also emphasizes the importance of planning for implementation and evaluation to ensure the provision of effective intervention services.

This model, like any model, has limitations. First, the activities are likely to be fluid—that is, activities may be completed out of order and still lead to effective implementation. Second, some prevention services providers may not have the resources to carry out all of the activities. For instance, smaller CBOs might not have resources for outcome evaluation. Third, the roles of prevention researchers and linking agents vary

over time, being more directive during preimplementation and more responsive as TA requests are made during implementation and maintenance and evolution (Feller, 1987). Prevention programs might use this model to assess where they are in the process of technology transfer and to identify key individuals in their organizations and in informal networks who might help guide them through the process.

The transfer of interventions from researchers to prevention services providers involves the collaboration of participants at various levels, with prevention services providers' needs and activities central throughout the process. The needs of prevention services providers and barriers to communication between researchers and providers suggest the need for linking agents who use their knowledge of research findings and prevention needs to help develop and disseminate intervention packages, plan for implementation, train staff and volunteers, and secure technical assistance. The involvement of participants at multiple levels requires coordinated efforts to ensure that the system of communication and activities meets the needs of prevention services providers seeking to implement interventions that motivate and sustain behavior change.

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External participants

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Laurie J. Bauman, *Albert Einstein College of Medicine*
Ruthann Bates, *Aspen Systems Corporation*
Mark Colomb, Assistant Director, *Division of STD/HIV (Mississippi)*
Richard Duran, *Education Development Center, Inc.*
Ellen Goldstein, *Center for AIDS Prevention Services*
Leanne Guy, *Intertribal Council of Arizona*
Katherine Haynes-Sanstad, *Center for AIDS Prevention Services*
Robert Hays, *Center for AIDS Prevention Services*
Timothy Heckman, *Center for AIDS Intervention Research*
Susan Kegeles, *Center for AIDS Prevention Services*
Jeffrey A. Kelly, *Center for AIDS Intervention Research*
Darryl Lampkin, *American Psychological Association*
Sutherland Miller, *Columbia University Medical School*
Glen Nowak, *University of Georgia*
Steve Pinkerton, *Center for AIDS Intervention Research*
Julie Redman, Program Manager, *HIV Prevention (Louisiana)*
Cornelis A. Rietmeijer, *Denver Health and Hospital Authority*
Valerie Rochester, *National Council of Negro Women*
Alexi San Doval, *Education Development Center, Inc.*
Phyllis Scattergood, *Education Development Center, Inc.*
L. Yvonne Stevenson, *Center for AIDS Intervention Research*
Tim White, *Center for AIDS Intervention Research*
Wayne Wilson, Branch Head, *HIV/STD Control Section (North Carolina)*

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